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TSUGA

(hemlocks)

Four of the 10 or more species of hemlocks (*Tsuga*) are North American, 2 eastern and 2 western. The others are in temperate Asia, Himalayas, mainland China, Taiwan, and Japan.

These conifers have slender, nodding leading shoots, irregular horizontal to drooping branches, and deeply furrowed cinnamon-red bark. The rounded buds are not resinous. The needlelike leaves are usually flattened and arranged in 2 rows and have minute petioles above the peglike stalks, which remain on the twigs. The flexible needles are rounded or notched at end, contain 1 resin canal, and persist 3 to 6 years.

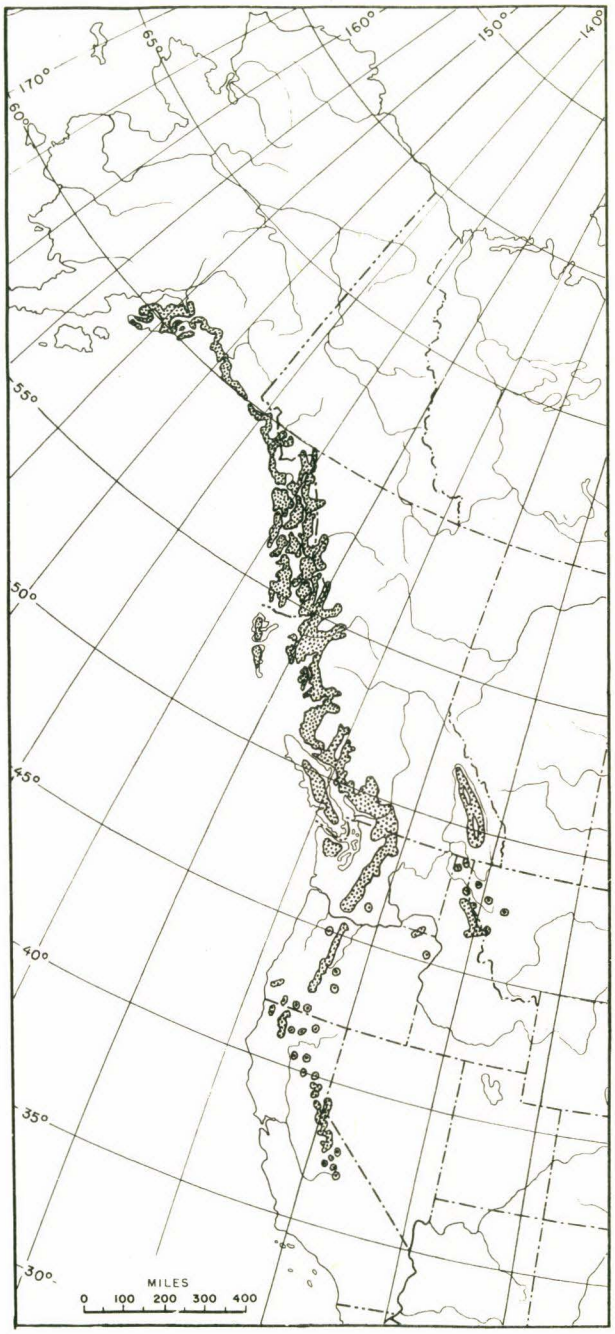
Male and ovulate strobili are produced on the same tree in spring from buds of the previous year, the former at leaf bases and the latter terminal. The small egg-shaped or cylindric cones hang down and mature in one season but remain attached until next year. The thin rounded cone scales bear at base paired long-winged seeds. Cotyledons 3 to 6.

F–490506

MOUNTAIN HEMLOCK (*Tsuga mertensiana* (Bong.) Carr.)

Other common names: Black hemlock, Patton spruce, Williamson spruce, hemlock spruce, alpine spruce, and alpine hemlock.

Mountain hemlock grows from the south fork of Kings River in California (lat. 36°40′) northward along the Sierra Nevada, the Cascades, and the coastal mountains of British Columbia, to the Kenai Peninsula in southern Alaska (lat. 61°10′). It also grows in the mountains of southeastern British Columbia, western Montana, northern Idaho, and the Blue Mountains of northeastern Oregon and southeastern Washington.



F–506677

The range of mountain hemlock.

HABITAT CONDITIONS

Climate

The principal climatic features of the mountain hemlock zone are long, cold winters; short growing seasons; and high precipitation, with a large part of it falling in the form of snow. Records from weather stations within the mountain hemlock range in Oregon, Washington, and Alaska show a variation in temperature from −20° to 101° F. and in average annual frost-free days from 79 to 149. Greatest precipitation and longest frost-free period is shown for that part of its range in Alaska.

Weather stations are generally sparsely distributed over the range of mountain hemlock and are nonexistent in large areas such as the high Sierra of California. It would not be surprising if weather extremes cited were all exceeded within the zone where the species grows.

In British Columbia, the following climatic regime has been proposed for the "Subalpine Mountain Hemlock" bioclimatic zone: Mean annual temperature 34° to 40° F.; 50 to 100 frost-free days; 87 to 170 inches of precipitation, the majority falling in the fall and winter; and 170 to 800 inches of snow constituting 20 to 70 percent of the total precipitation (*19*).[1]

The distribution of mountain hemlock in northern California appears to coincide with the lines of heaviest precipitation (*21*). But in coastal Alaska, mountain hemlock is able to survive more continental climatic conditions (less humid and greater temperature extremes) than any of the other coastal conifers (*17*).

Soils and Topography

Over its range, mountain hemlock grows on soils derived from a wide variety of parent materials including those of volcanic, sedimentary,

[1] Italic numbers in parentheses refer to Literature Cited, p. 715.

metamorphic, and glacial origin. However, mountain hemlock is rare and stunted on calcareous soils (those derived from limestone) in the Selkirks and Canadian Rockies, in contrast to its size and abundance elsewhere in these areas (*2*). It occurs, but usually does not grow well, on various types of peat.

Best development is on loose, coarse-textured, well-drained soils wherever sufficient moisture is available. In the southern half of its range, soil moisture appears to be by far the most important soil characteristic. Several investigators (*23*, *24*, *26*, *33*) have noted its tendency to occur on more mesic sites. The distribution of mountain hemlock on Mount Shasta seems to furnish an index to soil moisture (*23*). Farther south in the Sierra, it occurs along the line of seep water occurrence at the foot of talus slopes (*26*). Mountain hemlock can grow on very thin, rocky soils and even on recent lava flows and coarse deposits of volcanic ash and pumice provided sufficient moisture is available (*24*).

Mature soils typically found under mountain hemlock stands are podsols with a mor-type humus (*8*, *9*, *19*).

Extensive stands of mountain hemlock sawtimber are found near sea level in Alaska. Southward in its range, it is found at higher elevations as an important component of the subalpine forest zone. It commonly occurs at 3,000 to 5,000 feet in British Columbia, at 4,000 to 7,000 feet in the Cascade Range, at 5,500 to 9,000 feet in western Montana and northern Idaho, and at 6,000 to 11,000 feet in the Sierra Nevada of California. Mountain hemlock is a high-elevation species generally and occurs to timberline throughout its range.

The tree reaches its best development on flats and gentle slopes and at the heads of moist valleys or sheltered ravines. The best stands occur along the broad crest region of the Cascade Range in central and southern Oregon. North slopes are better sites through most of its range. It is often abundant on high, exposed slopes but is usually stunted on such sites. In British Columbia it grows at lower elevation on poorly drained sites where other species offer little competition.[2]

Associated Trees

Mountain hemlock is common in the Hudsonian and upper Canadian Life Zones and is a major component of the Mountain Hemlock—Subalpine Fir Type (Type 205). It or western hemlock, with Pacific silver fir, form the Pacific Silver Fir—Hemlock Type (Type 226). In addition, mountain hemlock is found in these types: White Spruce—Birch (Type 202), Engelmann Spruce—Subalpine Fir (Type 206), Red Fir (Type 207), Whitebark Pine (Type 208), and Western Hemlock (Type 224).

Mountain hemlock grows in uneven-aged or even-aged stands, either pure or in mixture. It is associated with a wide variety of tree species throughout its range. Common associates in Alaska and British Columbia are Sitka spruce, Alaska-cedar, Pacific silver fir, western hemlock, and subalpine fir. In Oregon and Washington it commonly grows with these species (excepting Sitka spruce) and with whitebark pine, subalpine larch, Engelmann spruce, lodgepole pine, western white pine, noble fir, and Shasta red fir. In California, common associates are California red fir, whitebark pine, lodgepole pine, and western white pine; in Idaho and Montana it associates with whitebark pine, subalpine larch, Engelmann spruce, and subalpine fir.

LIFE HISTORY

Reproduction and Early Growth

Flowering and seed production.—Pollination takes place in June in the Oregon Cascade Range, and from June to mid-July in British Columbia [3] and Alaska (*16*). Temperature appears to be a critical factor in pollen dispersal of mountain hemlock.[4] In one study in British Columbia (*12*), mountain hemlock was the last of 10 species under investigation to shed pollen. Cones ripen and seeds are shed in late September and October.

Mountain hemlock is a prolific seed producer and bears some seed almost every year. During years of heavy crops, which occur every few years, cones are so numerous as to weight down the branchlets and almost cover them. A recent study suggests there may be a relationship between July temperatures and the initiation of flower primordia in mountain hemlock.[5] Some trees began bearing cones by the time they are 20 years old. The small brownish seeds equipped with large wings are well suited to distribution by wind. Seed may be of poor quality some years but insect damage appears to be light; only three insects are known to injure cones and seeds, and one which damages only the seed.

Seedling development.—The seeds are of transient viability. Germination takes place on either organic or mineral soil seedbeds if sufficient moisture is present. Young seedlings grow best in partial shade and initial development is very slow.

[2] Information furnished by R. L. Schmidt, British Columbia Forest Service.

[3] Ebell, L. F., and Schmidt, R. L. The influence of meteorological factors upon dispersal of coniferous pollen on Vancouver Island, British Columbia. Unpublished manuscript. 1962.

[4] See footnote 2.

[5] See footnote 2.

Early workers in southern Oregon and northern California (*20*, *21*, *27*) noted that mountain hemlock reproduces plentifully, except at upper altitudes. Many of the stands are nearly pure with some 20- to 40-year-old stands having 4,000 to 10,000 trees per acre. Some of these are on old burned areas. In central Oregon, mountain hemlock is aggressive in invading small openings and meadows at high elevations.[6] It also appears to be the species most capable of recovering from damage caused by snow creep and snow mold (*Herpotrichia* sp.). In British Columbia and Alaska it also pioneers on glacial moraines (*5*, *22*) and is capable of invading and establishing itself in adjacent heather communities (*1*, *7*). It may not be a pioneer in southeastern British Columbia (Selkirk Mountains) as it is rarely present on recently disturbed areas such as glacial moraines, avalanche tracts, or burns (*3*).

Vegetative reproduction.—Hemlocks will reproduce by layering (*6*, *22*). Other forms of vegetative reproduction may be possible.

[6] Swedberg, Kenneth C. 1961. The coniferous ecotone of the east slope of the northern Oregon Cascades. Unpub. Ph. D. thesis, Oregon State University, 118 pp.
VanVechten, George Wendell. 1960. The ecology of the timberline and alpine vegetation of the Three Sisters, Oregon. Unpub. Ph. D. thesis, Oregon State University, 111 pp.

F–496492
Mountain hemlock replacing lodgepole pine near Olallie Lake, Oreg.

F–191319
Mature mountain hemlock on the Mt. Baker National Forest, Wash.

Sapling Stage to Maturity

Growth and yield.—Mature trees usually range in height from 50 to 100 feet; they reach 100 to 125 feet on better sites and occasionally up to 150 feet. Diameters vary from 10 to 20 inches over much of its range and occasionally from 30 to 40 inches on the best sites (*10*). The largest diameter recorded was 83.1 inches, but the tree was only 118 feet tall. On high, exposed ridges, mountain hemlock may develop as a sprawling shrub.

Mountain hemlock is thought to attain an age of 400 to 500 years. It grows so slowly that trees 18 to 20 inches in diameter are usually from 180 to 260 years old.

Reaction to competition.—Mountain hemlock is rated as tolerant, and may surpass all of its associates except western hemlock in this respect. However, Pacific silver fir is also thought to be another more tolerant associate.[7]

[7] Information furnished by E. H. Garman, British Columbia Forest Service.

Mountain hemlock is considered a climax species, by almost every investigator, of forest stands in which mountain hemlock was a major component. In some of the mixed stands of mountain hemlock and Pacific silver fir found in the southern Washington and northern Oregon Cascades, it may not be a climax dominant, however, because reproduction often is not nearly as abundant nor as vigorous as that of Pacific silver fir.

Mountain hemlock seedlings and saplings readily survive long suppression and resume normal growth when light is admitted. Natural pruning is usually poor, with some branch stubs persisting almost to the ground even in crowded stands. However, good natural pruning in even-aged stands in British Columbia is reported.[8]

Principal enemies.—Dwarfmistletoe (*Arceuthobium campylopodum* forma *tsugensis*) is a common and damaging parasite which causes brooming, spike tops, a reduction in vigor, and sometimes the death of trees (*13*). It attacks mountain hemlock throughout most of its range (*32*).

Trunk and butt rots known to attack mountain hemlock include *Echinodontium tinctorium*, *Fomes annosus*, *F. pini*, *F. pinicola*, and *Polyporus schweinitzii* (*14*, *15*, *25*). *Poria weirii* has recently been reported killing mountain hemlocks in central Oregon (*29*). Mountain hemlock is attacked by Indian paint fungus (*E. tinctorium*) only in British Columbia (*28*). It is not attacked in the coastal forests. Infection reaches a maximum in the drier interior region of southeastern British Columbia. Mountain hemlock sometimes has extensive heart-rot but is generally more sound than associated western hemlock.

Several needle rusts and needle casts and a snow fungus or mold (*Herpotrichia nigra*) are also known to attack mountain hemlock but are not considered serious.

A number of insects attack mountain hemlock, but seldom kill any large number of trees. The black-headed budworm (*Acleris variana*) and the hemlock sawfly (*Neodiprion tsugae*) at times defoliate and weaken or kill mountain hemlock although this species does not appear to be the preferred host. The flatheaded fir borer (*Melanophila drummondi*) and hemlock engraver (*Scolytus tsugae*) commonly kill weakened trees. Various other insects bore into the wood of dying and dead trees and into unseasoned lumber.

As cutting increases in the higher-elevation forests, windthrow will probably become a more important cause of mortality. Seedlings are sometimes injured by snow creep and mature specimens growing on steep slopes often are "pistol-butted" as a result. Mountain hemlock is considered to be highly susceptible to fire because of its poor pruning and tendency to occur in clusters.

[8] See footnote 2, p. 713.

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RACES AND HYBRIDS

Tsuga jeffreyi, a natural hybrid between western and mountain hemlocks (*18*), probably resulted in the areas where the two species mix, as on Mt. Rainier and Mt. Baker in Washington and on Vancouver Island.

Some French taxonomists (*4*, *30*, *31*) propose that mountain hemlock is a hybrid between Sitka spruce and western hemlock and have renamed it *Tsugo-Picea hookeriana*. A California variety of mountain hemlock, previously named *T. crassifolia*, they consider to be a cross between mountain hemlock and Engelmann spruce, which they renamed *Tsugo-Piceo-Picea hookeriana*. These views have been questioned by foresters familiar with these species in their natural environments (*11*).

Revised from "Silvical Characteristics of Mountain Hemlock," by Walter G. Dahms. U.S. Forest Serv. Pacific Northwest Forest and Range Expt. Sta. Silvical Rpt. 11, 8 pp. 1958 (with subsequent revision by Jerry F. Franklin).

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